

(NASA-CR-196788) NITROGEN AND
CARBON CYCLING ALONG THE OREGON
TRANSECT Final Report (Oregon
State Univ.) 6 p

N95-70128

Unclass

29/45 0022272

Oregon State Univ
CorvallisTO
CASE

FINAL REPORT

Nitrogen and Carbon Cycling along the Oregon Transect, NAG 2-719

AUG 02 1994

As part of the large, multidisciplinary OTTER project, we collected data a several soil and vegetation variables. These efforts focused mainly on N cycling, especially at the Scio (site 3) location, which was one of the more intensively studies sites. This report briefly summarizes our efforts and the data obtained.

7N-45-02
OCT. 22 272
6P

Methods

Plot Locations. Three sites: Cascade Head, Scio, and Black Butte. There were two treatments at Cascade Head--mature red alder stand and mature western hemlock/sitka spruce stand; three treatments at the Scio Douglas-fir/western hemlock site--unfertilized, once fertilized (450 kg N ha^{-1} in 1988), and twice fertilized (450 kg N ha^{-1} in 1988, and additional urea fertilization of 300 kg N ha^{-1} in April 1990, 160 kg N ha^{-1} in November 1990, 30 kg N ha^{-1} in April 1991, and 160 kg N ha^{-1} in December 1991); two treatments at the Black Butte ponderosa pine site--unsludged and sludged. Within each treatment at each site, four 17-m radius plots were installed and within each plot, four randomly selected sample points were selected. This was in essence a stratified (i.e., plot) random (i.e., sample point) design. We used all four sample points (a total of 16 samples per treatment) for the quarterly soil N and soil moisture sampling; we used only three of the four sample points for litterfall and root studies (a total of 12 samples per treatment). Soil moisture measurements at "non-quarterly" sampling dates and at the juniper and Santiam Pass sites were done with fewer (4 to 10), composite samples.

N Cycling. N cycle rates were determined quarterly using a resin core method. This involved taking a 0-20 cm soil sample using a 2-cm diameter Oakfield corer for measuring initial NH_4^+ and NO_3^- concentrations. A 5.1-cm diameter by 25 cm long PVC tube was inserted into the soil to a depth of 20 cm and removed. A nylon bag containing 20 g dry weight of a mixed-bed ion exchange resin was placed at the bottom of the core and the complete resin core was reinserted into the soil. After about three months, the in-place resin cores were removed, another Oakfield soil sample taken, and a new resin core implanted. Resin cores were sampled at nine dates, which gives eight, three-month measurement periods. The dates are as follows: 1--23 Mar 1990, 2--7 Jun 1990, 3--14 Oct 1990, 4--4 Dec 1990, 5--15 Mar 1991, 6--2 Jun 1991, 7--9 Oct 1991, 8--5 Jan 1992, and 9--2 Apr 1992. The soil within the resin core was sampled for measuring final NH_4^+ and NO_3^- concentrations and amounts of NH_4^+ and NO_3^- trapped on the resin were measured.

Soil NH_4^+ and NO_3^- concentrations were measured by extraction about 10 g dry weight of soil in 50 ml of 2 N KCl. Resin bag NH_4^+ and NO_3^- concentrations were measured similarly by extracting each resin bag in 50 ml of 2 N KCl. Concentrations of NH_4^+ and NO_3^- were measured with and Alpkem autoanalyzer using the salicylate/nitroprusside chemistry for NH_4^+ and Cd-reduction followed by diazotization for NO_3^- . The data were extrapolated to an areal basis by knowing the surface area of the resin cores and the total weight of soil in the resin cores (this weight to surface area was ratio was also used for extrapolating the Oakfield soil samples to an areal basis. The amount of NH_4^+ and NO_3^- that accumulated in the soil and on the resin bag of the resin core minus the amount of NH_4^+ and NO_3^- in the initial Oakfield sample was used to calculate net N mineralization. The analogous arithmetic using only NO_3^-

data yield net nitrification. The amount of NH_4^+ and NO_3^- that accumulated on the resin is an indication of potential leaching losses of N. Estimates of plant N uptake can be obtained by subtracting the difference in soil NH_4^+ and NO_3^- content outside the resin core at the end of an incubation (this is the initial for the next quarterly incubation) and that at the beginning of the incubation from the net N mineralization.

Root Dynamics. Initial fine root biomass was determined by taking 6.1-cm diameter by 34-cm deep soil cores (1000 cm^3 total volume) and hand sorting all roots $< 3 \text{ mm}$ in diameter. These fine roots were dried at 70°C and weighed. Root growth was determined by excavating the same size hole and refilling it with root-free soil. After a three-month interval, the root ingrowth cylinder was exhumed and fine roots quantified by picking and weighing. Root samples have been saved for starch analysis.

Litterfall. Littertraps ($50 \times 50 \text{ cm}$ square) were constructed of cedar 1x2's and fiberglass window screening. Littertraps were positioned about 30 cm above the forest floor. Only leaf litter (needles) was measured; twigs and other debris were removed. At monthly intervals, the littertraps were emptied, the litter dried at 70°C , and weighed. Litter samples were saved for total N analysis.

Soil and Litter Moisture Content. Gravimetric water contents of soil and litter were done by drying at 110°C and 70°C , respectively, and weighing. Notes were made as to the composition of the soil sample, i.e., mineral soil, decaying wood, and mixed organic and mineral material.

Results and Discussion

Soil Moisture. Fluctuations in soil moisture from March 1990 to June 1991 for the Scio and Black Butte sites are shown in the Fig. 1 and 2. The horizontal lines on these graphs represent the upper and lower limits of available water at these sites. Similar data for soil and litter water content are available for all sites.

Litterfall. Cumulative litterfall mass from June to October 1990 was 3.13 Mg ha^{-1} for the Cascade Head red alder stand (Table 1). At Scio, litterfall inputs of 6 to 7 Mg ha^{-1} were recorded for a one-year period starting in June 1990. The N inputs through litterfall were consistent with the rates of N_2 fixation that commonly occur in red alder stands and also show the response of the conifers to N fertilization at the Scio site.

Table 1. Litterfall characteristics.

Site	Litterfall ($\text{Mg ha}^{-1} \text{ yr}^{-1}$)	Litter N concentration (%)	Litter N input ($\text{kg ha}^{-1} \text{ yr}^{-1}$)
Cascade Head red alder	3.13(0.22) ^a	1.98	62.0
Scio			
control	5.75(0.85)	0.41	23.6
1x fertilized	6.83(1.17)	0.60	41.0
2x fertilized	6.61(1.09)	0.62	41.0

^amean(standard error), n=4.

Root Dynamics. There were no significant differences in fine root biomass among the Scio treatments in the March measurement (Table 2). From June 1990 to June 1991, the control produced about 40 % more roots than intensively fertilized plot. Root inputs were about only 15 to 25 % of litterfall inputs at the Scio site.

Table 2. Root biomass and growth at Scio (site 3).

Treatment	Initial Biomass (Mg ha ⁻¹)	Ingrowth (Mg ha ⁻¹)			Annual production (Mg ha ⁻¹)	Turnover (yr ⁻¹)
		Jun-Oct	Oct-Mar	Mar-Jun		
Fertilized	2.99(0.45) ^a	0.50(0.23)	0.17(0.07)	0.26(0.08)	0.93(0.25)	0.31(0.10)
Control	3.21(0.48)	0.61(0.31)	0.55(0.39)	0.25(0.05)	1.40(0.50)	0.44(0.17)

^amean(standard error), n=4 for biomass, n=3 for ingrowth.

N Cycling. The N mineralization data were extremely variable. At Cascade Head (Fig. 3), N mineralization was much greater in the red alder stand, as expected for a stand that gets a large input of N via N₂ fixation. Nitrogen mineralization rates were generally lower at Scio (Fig. 4) and showed a trend toward increasing N mineralization with increasing fertilization. The extremely high N mineralization rate of the intensively fertilized plot for the October to December 1990 period undoubtedly reflects the input of fertilizer N from the November urea fertilization. The Metolius, or Black Butte, site (Fig. 5) had the lowest N mineralization rates. Pulses of N mineralization in the spring and fall likely coincide with periods of moist, warm soils.

Data Archives. All data were submitted to the database managers and are available on the OTTER CD-ROMs.

Summary

Our role was basically to provide "ground truth" support for the modeling and remote sensing tasks of OTTER. To this end, we determined quarterly net N mineralization, net nitrification, N leaching rates, and N uptake rates for the seven treatments at the three primary sites (Cascade Head, Scio, and Black Butte). At Scio, we cooperated with Dick Waring and Kim Matson on measuring fine root dynamics in the three N fertilization treatments. In particular, we measured standing fine root biomass and quarterly measurements of root growth using root ingrowth cores. Monthly litterfall was monitored at the Scio and Cascade Head red alder treatments. On a monthly basis, we took gravimetric moisture samples of soil and, where applicable, litter at the three primary sites and the juniper and Santiam Pass sites.

SCIO

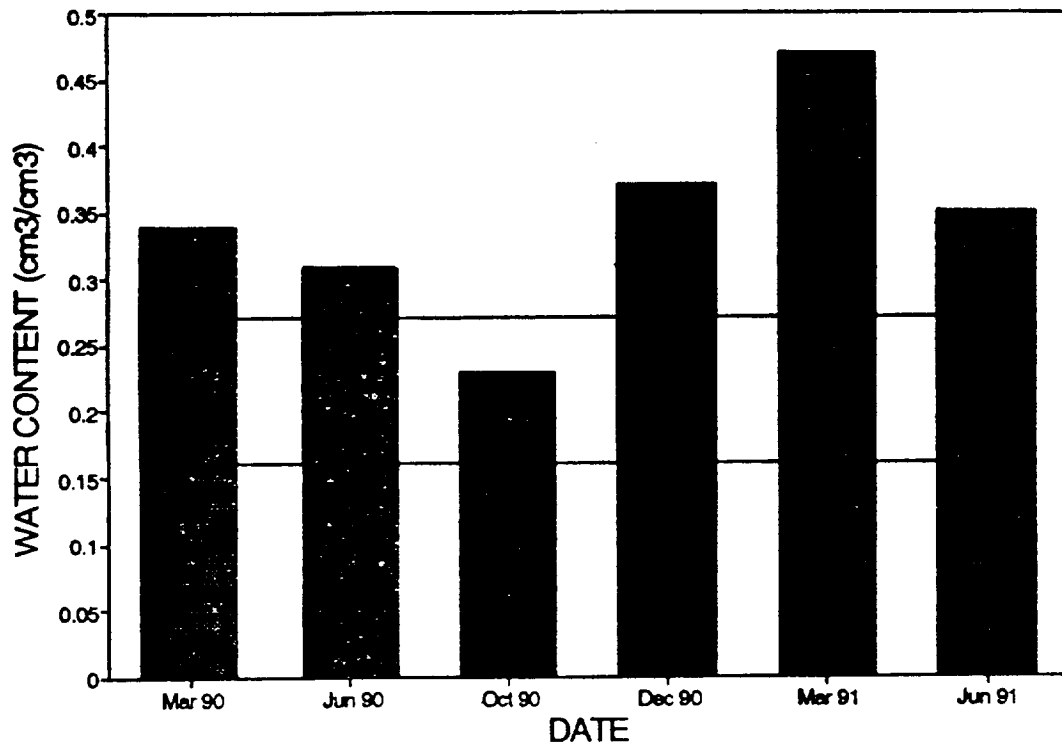


Fig. 1

BLACK BUTTE

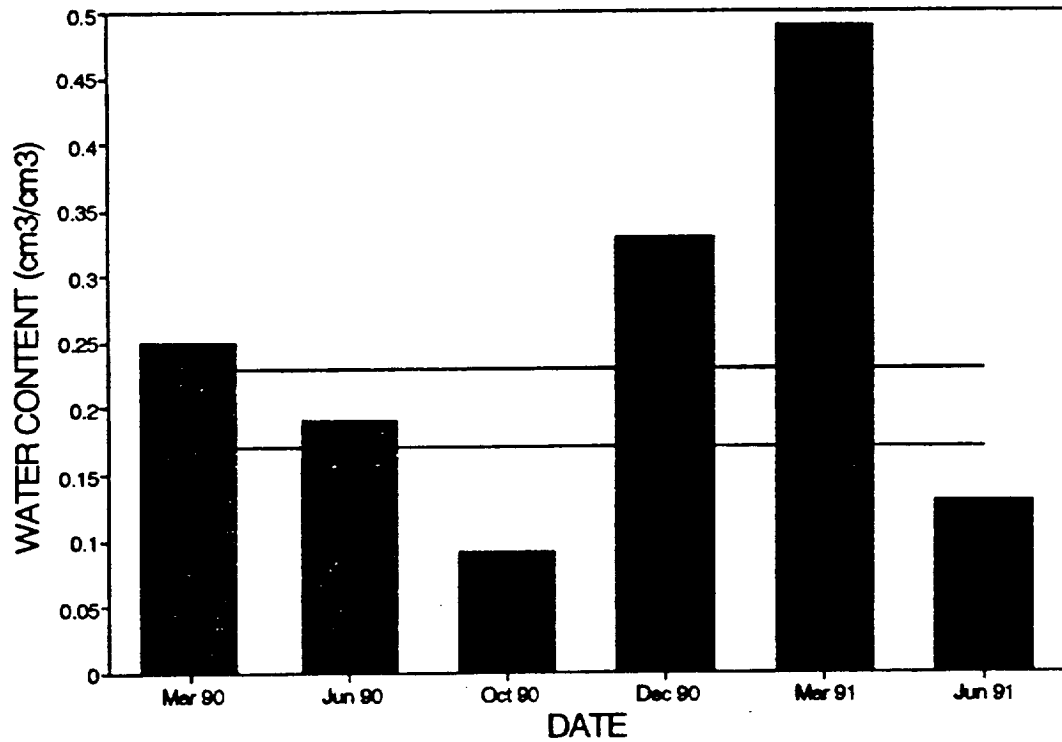


Fig. 2

CASCADE HEAD

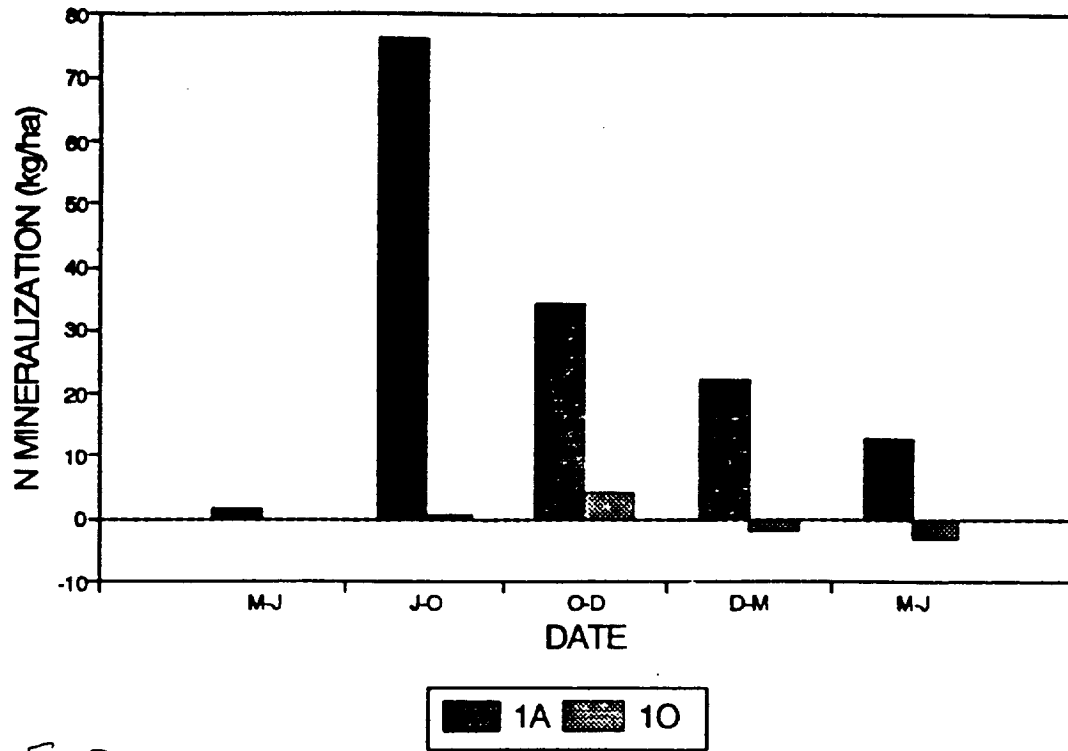


Fig 3

SCIO

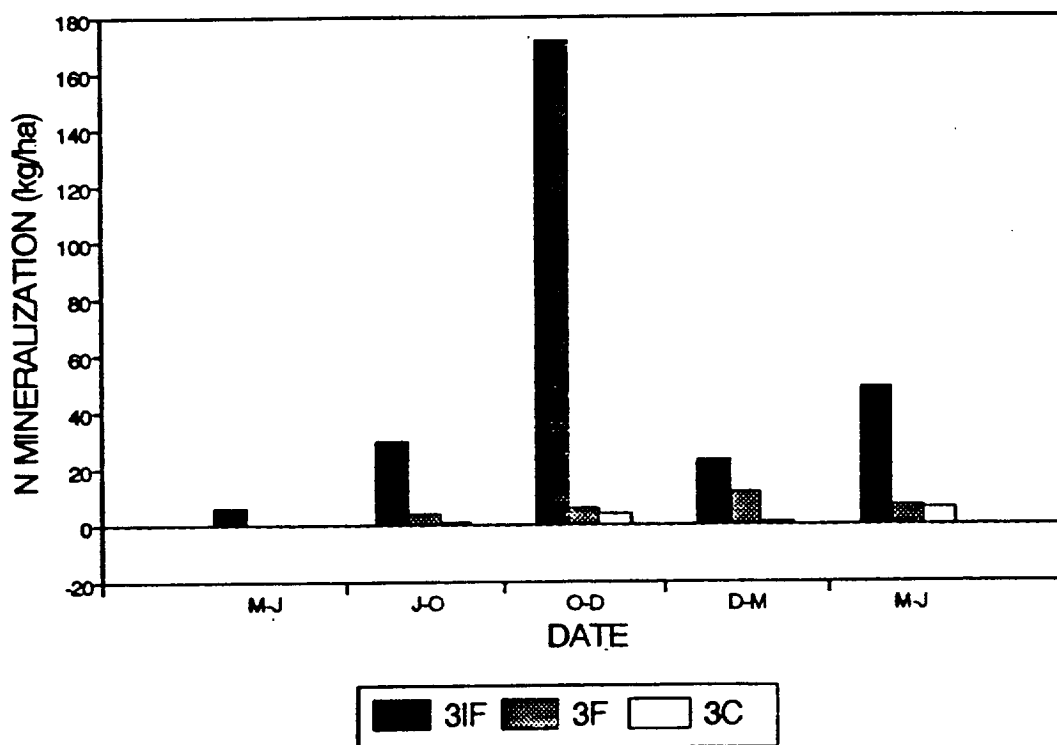


Fig. 4

METOLIUS

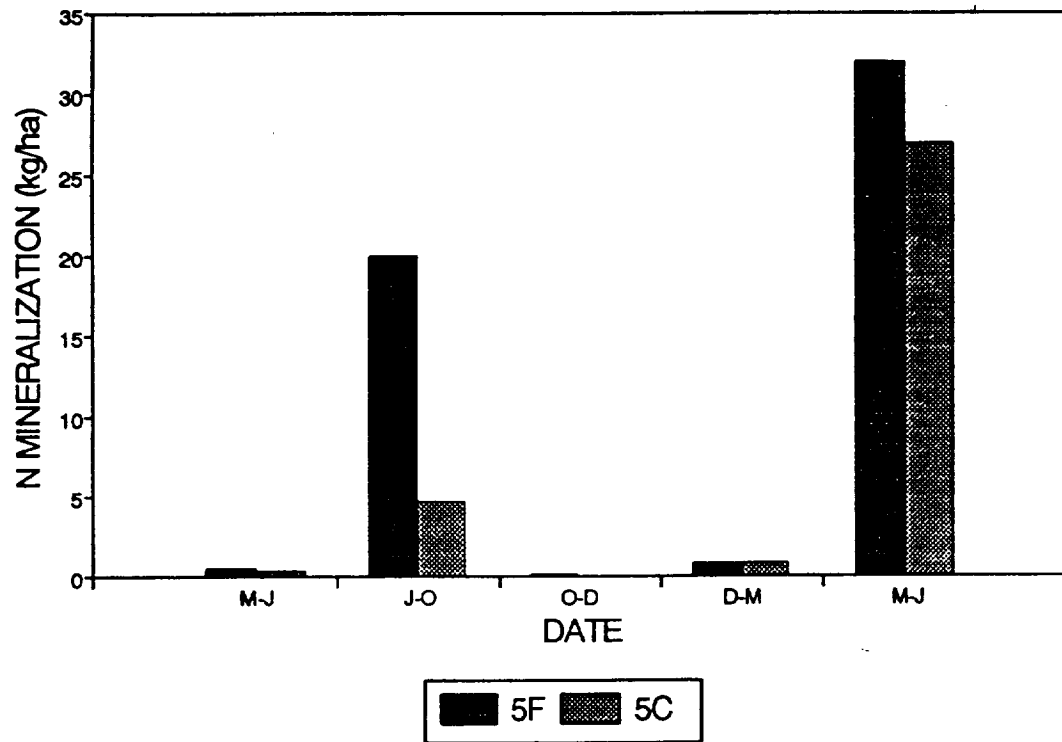


Fig. 5